



Global Advanced Research Journal of Management and Business Studies (ISSN: 2315-5086) Vol. 3(11) pp. 519-521, November, 2014

Available online <http://garj.org/garjmbs/index.htm>

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Full Length Research Paper

Relationship between annual electricity production (kwh) and physical GDP (US dollar) per capita: An empirical index for measuring the level of economic development of a nation

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Accepted 10 November 2014

This paper presents an empirical index for estimation of economic development level and living standard of a country based on the relationship between annual electricity production (kwh) and physical GDP per capita (gross domestic product contributed by agriculture and industry) (in US dollar). The values of annual electricity production per capita (AEPPC) is positively correlated with physical GDP per capita for selected eight nations, suggesting that the higher AEPPC would indicate higher degree of economic development and living standard of a country despite the presence of notable exception. The AEPPC can be used as an empirical index to assess economic development and living standard of a nation.

Keywords: Annual electricity production per capita (AEPPC); physical GDP per capita; living standard; economic development level

INTRODUCTION

The World Factbook compiled by the Central Intelligence Agency (CIA) of the US government (<https://www.cia.gov/library/publications/the-world-factbook/>) is a key source for information on the history, people, government, economy, geography, communications, transportation, military, and transnational issues for 267 world entities. This paper uses the data from the CIA World Factbook 2012 to

compare eight countries (i.e. Canada, Germany, USA, Japan, Russia, China, South Africa, India) that represent developed and developing countries in terms of annual electricity production per capita (AEPPC) and physical GDP per capita (in US dollar) to estimate the real level of economic development and living standard of these nations. Here, physical GDP per capita refers to the value contributed by the sectors of agriculture and industry

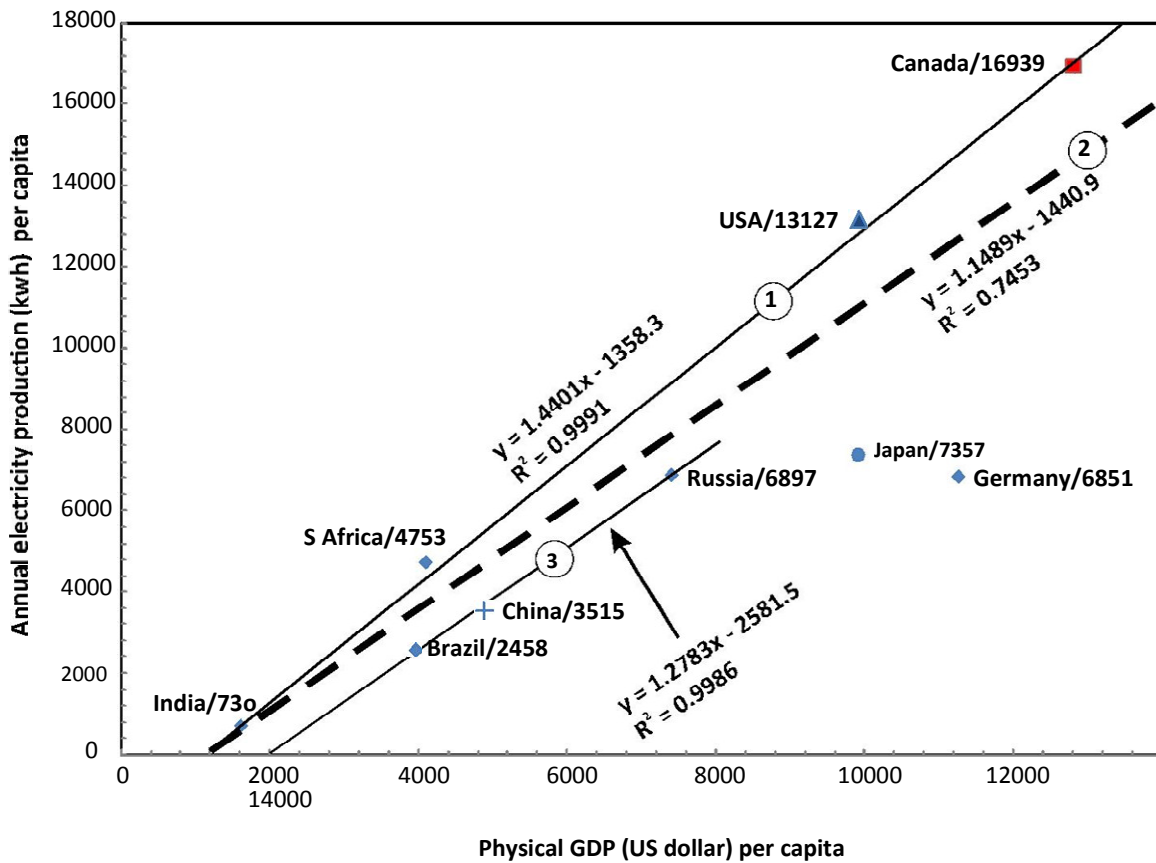


Fig. 1 Diagram of annual electricity production per capita (kwh) versus physical GDP per capita (in US dollar). Data from the CIA World Factbook 2012 (see Table 1). Three lines are indicated: line 1 includes 4 countries (Canada, USA, South Africa, and India); line 2 includes all 8 countries; line 3 includes only three countries (Russia, China, and Brazil).

only, excluding the sector of service (see the World Factbook, CIA). The AEPPC is thus able to be as an empirical index to assess economic development and living standard of a nation.

METHOD AND ANALYSIS

The Data used in this study are from the CIA World Factbook 2012 (Table 1), which are plotted in Fig. 1 using annual electricity production per capita versus physical GDP per capita (in US dollar). This graph shows a positive correlation between annual electricity production (kwh) per capita and physical GDP (US dollar) per capita as shown by line 2 (regression analysis gives an equation: $y = 1.1489x - 1440.9$; $R^2 = 0.7453$; where y is annual electricity production (kwh) per capita, x is

physical GDP per capita (in US dollar), and R is correlation coefficient) that includes all eight countries. Physical GDP denotes that the GDP contributed by the sectors of industry and agriculture but excluding service sector.

Canada and USA are the leading countries in these parameters considered in this study, generating higher electricity and more valuable products per capita relative to the other nations (Fig. 1). Germany and Japan produced higher material products with generating relatively lower electricity per capita, being of exceptionally high energy efficiency compared to the other nations as suggested by these two countries plotting far away from the general trend indicated by the thick dash line 2. Russia, China, Brazil and India fall on the similar trend to Canada and USA, but generating relatively lower electricity and lower amount of goods per

Table 1 Economic data (Data from the CIA World Factbook 2012)

	Canada	Germany	USA	Japan	Russia	China	South Africa	Brazil	India
GDP (trillion dollars US)	1.446	3.111	15.32	4.444	2.509	11.48	0.578	2.362	4.421
Agriculture GDP (trillion dollars US)	0.03	0.02	0.18	0.05	0.11	1.148	0.014	0.13	0.76
Industry GDP (trillion dollars US)	0.41	0.89	2.94	1.21	0.94	5.35	0.186	0.65	1.17
Service GDP (trillion dollars US)	1.01	2.20	12.19	3.18	1.46	4.97	0.379	1.59	2.49
Physical GDP (Agriculture + Industry)	0.44	0.91	3.13	1.26	1.05	6.51	0.20	0.77	1.93
Population	34,300,083	81,305,856	313,847,465	127,368,088	142,517,670	1,343,239,923	48,810,427	199,321,413	1,205,073,612
Annual electricity generation (kwh*trillion)	0.581	0.557	4.120	0.937	0.983	4.722	0.232	0.490	0.880
Physical GDP per capita	12,816	11,251	9,958	9,909	7,394	4,846	4,085	3,887	1,600
Annual electricity production per capita (kwh)	16939	6851	13127	7357	6897	3515	4753	2458	730

capita. Using China as an example, its per capita physical GDP (\$4846) is only 51.3% of USA (\$9958) in 2012, but China's per capita annual electricity production is less than one-third of USA. India is located at the bottom regarding physical GDP (\$1600) and annual electricity production (730 kwh) per capita. This simple comparison suggests that the nation with higher electricity production per capita must have higher physical GDP value per capita, thus may have enjoyed higher standard of living.

Two general additional trends are discernible (Fig. 1): 1) India, South Africa, the USA, and Canada falling on a line (line 1); 2) Brazil, China, and Russia casting the other line (line 3) with slightly smaller slope. This strongly suggests a general tendency of industrial development, higher annual electricity production resulting in higher physical GDP per capita. A question is raised for the outlets indicated by the data of Germany and Japan. These two countries generate higher physical GDP with producing relatively less electricity per capita. Each German yielded \$11251 US of physical GDP in 2012 by producing 6851 kwh, whereas Russian generated \$7294 US in the same year by producing 6897 kwh. This is intriguing that one Russian used 47 kwh electricity more a year, but produced \$3857

US physical GDP less than a German. How is this possible? More factors are required to assess the data.

A prediction may be made for India on the basis of the trend as described above, that if one Indian would produced 13127 kwh in 2012 as an American did, then this Indian must have produced \$9958 US physical GDP that year. Thus, to catch up the level of economic development of USA, India has a long way to go (Fig. 1).

Fig. 1 demonstrates that a Japanese produced \$9909 US physical GDP in 2012, almost the same as an American (\$9958 US), but only used little more than half electricity used by the American. Again, electricity used for producing goods in Japan is in higher efficiency than that in the USA.

DISCUSSION

The AEPPC is a simple empirical index that may be used to assess economic development and living standard of a nation as shown above. More factors are required to consider to see how a nation performs in terms of electricity production and physical GDP creation. Canada, for example, has the highest AEPPC, consistent with

Canadians enjoying relatively higher standard of living compared to other nations and demanding more power because of hush weather in very cold winter season. India, however, displays the lowest AEPPC, manifested by the lower higher standard of living and economic development level. Therefore, there is much big room to improve in economic development for India.

REFERENCES

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